ST. JOHN, GEORGE • WOODWORK

MANUAL INSTRUCTION

WOODWORK

DESIGNED TO MEET THE

REQUIREMENTS OF THE MINUTE OF THE SCIENCE AND ART DEPARTMENT

ON

MANUAL INSTRUCTION

BY

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LONDON AND EDINBURGH

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INTRODUCTION.

PUBLIC opinion has been so strongly pronounced with regard to Technical Instruction, that it is unnecessary to say anything in its favour here.

This little work is intended to meet the requirements of the Science and Art Department as contained in their minutes on Manual Instruction, lately issued. The writer has had special facilities for acquiring a thorough practical knowledge of the subject, and the work is the result of actual experience in teaching in his own school.

The cost of establishing classes in Manual Instruction in Elementary Schools is not so great as may be at first supposed, provided the school possesses the necessary accommodation for a workshop. The cost of a set of tools sufficient for the use of twelve boys is about £12, while the three benches necessary for that number of boys, and similar to the one described, would cost about £6. The cost of material has been carefully considered, and the lessons so arranged that where possible the material used in one lesson is made to serve for a future lesson.

The timber should be "*mild*," of good sound deal or pine, and free from knots and shakes. It is better to pay a little more to obtain this, as inferior timber cuts greatly to waste.

Full-size drawings of each piece of work must first be made, and the work tested as it progresses.

Some practice will first of all be necessary to accustom the pupils to the use of the saw and the plane, so that they can cut out and plane up a piece of stuff true to given dimensions. This accuracy is, however, necessary before they are allowed to go on with the more advanced work.

INSTRUCTIONS BY THE SCIENCE AND ART DEPARTMENT.

Form 813. *Manual Inst.*

DEPARTMENT OF SCIENCE AND ART OF THE COMMITTEE OF COUNCIL ON EDUCATION, LONDON, S.W.

At South Kensington, the 5th day of June 1890. By the Right Honourable the Lords of the Committee of her Majesty's most Honourable Privy Council on Education.

1. My Lords consider the Minute of the Rules for Granting Aid to Drawing in Elementary Schools.

2. With a view to develop this instruction in a practical direction, and to assist and encourage the formation of classes for Manual Instruction, grants will be made by the Department of Science and Art towards the maintenance of such classes in connection with Elementary Schools teaching Drawing under the foregoing rules; or in connection with organised Science Schools under § 27 of the Science and Art Directory.

3. The instruction must be—

(*a*) In the use of the ordinary tools used in handicrafts in wood or iron;

(*b*) Given out of school hours in a properly fitted workshop; and

(*c*) Connected with the instruction in drawing: that is to say, the work must be from drawings to scale previously made by the students.

4. The instruction may be given by one of the regular teachers of the school, if he is sufficiently qualified; if not, he must be assisted by a skilled artisan.

5. The work of the class will be examined by the local inspector of the Department, accompanied, if necessary, by an artisan expert, on the occasion of his visit to examine in drawing.

6. If it appears that the school is properly provided with plant for instruction, and that the teaching is fairly good, a grant of 6s., or, if excellent, of 7s., will be made for every scholar instructed, provided (*a*) that he has passed the Fourth Standard; (*b*) that he has received manual instruction for at least two hours a-week for twenty-two weeks during the school year; (*c*) that a special register of attendance is kept; and (*d*) that each scholar on whom payment is claimed is a scholar of the day-school, and has attended with reasonable regularity. The grant may be reduced or wholly withheld at the discretion of the Department, if it appears that the plant is insufficient or that the instruction is not good.

7. The managers of the school must inform the Department of Science and Art as soon as manual instruction is commenced in connection with their school.

8. If the grant be made for a period other than a year, the grant will be increased or diminished by one-twelfth for each month more or less than a year.

By order,

J. F. D. Donnelly.

Circular Letter 41. *Manual Inst.*

Department of Science and Art of the Committee of Council on Education, London, S.W.

18*th June* 1890.

Sir,—Referring to the minute of the 5th June 1890 giving aid for Manual Instruction in Elementary Schools, I am directed by the Lords of the Committee of Council on Education to state that the restriction in § 3 (*b*)—that the Manual Instruction shall be given out of school hours—does not prevent this instruction being included in the time-table of the school, provided that the time devoted to Manual Instruction by any scholar, for the purposes of the grant from the Department of Science and Art, does not include any part of the two consecutive hours of instruction in the subjects of the English and Scotch Codes requisite to constitute an attendance; or of the four hours a-day secular instruction requisite under the rules of the Commissioners of National Education in Ireland.—I am, sir, your obedient servant,

J. F. D. Donnelly.

Circular 44. *Manual Inst.*

Department of Science and Art of the Committee of Council on Education, London, S.W.

Suggestions for Manual Instruction.

The Lords of the Committee of Council on Education desire to leave the managers of schools as free as possible in formulating the course of Manual Instruction to be given under the minute of the 5th June 1890, for grants from the Department of Science and Art; provided that

this course be adapted to teach the use of tools employed in handicrafts, not so much as an initiation in a special handicraft as a disciplinary educational course to train the hand and eye to accuracy by a progressive series of exercises connected with freehand drawing and drawing to scale. As, however, many questions have been asked as to what precise form of instruction should be followed, the following observations have been prepared. These must, however, be considered more in the light of suggestions than regulations:—

Before commencing to work with tools, it will be found very useful to practise the children in cutting out and putting together solid models in cardboard or paper from plane projections (known technically as "nets").

All work with tools must, as stated in the minute, be from careful full-size drawings prepared by the scholar, the dimensions being taken off this drawing in the workshop.

The tools required for the early stages of manual instruction in carpentry are the saw, the plane, and the chisel. The construction and mode of use of these tools, the proper methods of sharpening them and of keeping them in good working order, should form the subjects for preliminary lessons. A great variety of exercises may be arranged, suited to the strength and ability of the scholar, in the use of these tools, which will give an elementary knowledge of the principles of construction, and at the same time teach accuracy and carefulness.

Clear ideas respecting the various kinds of hard and soft woods, the growth and structure of wood, its fibre and grain, may be given by means of a small collection of the different descriptions of timber commonly used in carpentry, with longitudinal and cross sections.

The earlier exercises should include some such as the following:—

Sawing off across the grain of the wood, and sawing along the grain of the wood, blocks and strips of given dimensions taken from a drawing prepared by the boy himself from a model, and having marked on it the required dimensions. Many varieties of tenon and of halved joints can be made in the rough by the saw alone.

The use of the plane can be commenced by planing small surfaces about 9 inches in width, and then planing down strips to a given thickness. The planing of two surfaces at right angles to each other, the preparation of a right square prism and of a hexagonal prism, and the construction of a straight-edge with bevelled edges, can follow.

The joints used by carpenters form a valuable series of exercises in which the use of the chisel may be learnt; such as the various forms of halving, of mortise and tenon, notching, dowelling, dovetailing, groove-and-tonguing, and scarfing with keys or wedges. The teacher should draw up a complete series of simple and graduated exercises for the early stages, which all members of the class should execute in turn. No attempts should be made at first to construct small articles of furniture.

The proper use of nails and screws should be explained and practised till a fair measure of accuracy has been attained.

So far the instruction does not involve the use of curved surfaces. If the workshop is provided with a lathe, another graduated series of exercises might be arranged to include the simpler forms of turning, but this is not insisted on.

There should be not less than four feet run of bench

for each boy under instruction, and he should have a space of at least two feet in width in front of the bench. The room should be well lighted and ventilated. There should be a bench and set of tools for the use of each scholar when under instruction, with a proper place in which to keep them, each bench being provided with a wood or metal vice, as the case may be. A teacher cannot properly direct the manual instruction of more than about twenty boys at one time.

By order,

J. F. D. Donnelly.

TOOLS REQUIRED.

1 trying-plane.
12 jack-planes.
12 smoothing-planes.
12 2-feet rules.
12 4½″ squares.
12 gauges.
12 mallets.
6 hammers.
6 tenon-saws.
4 hand-saws.
12 firmer chisels, ¼″.
12 " " ⅜″.
12 firmer chisels, ½″.
12 " " ⅝″.
12 " " ¾″.
12 " " 1″.
1 plough.
1 set match-planes.
1 mortise-gauge.
1 grindstone.
3 oil-stones.
12 bradawls.
1 glue-pot.
2 sawing-stools.

WOODWORK.

CHAPTER I.

GRINDING AND SHARPENING.

It is important that the pupils should early be taught to grind and sharpen their chisels and plane-irons. The angle at which cutting-tools are ground depends on the hardness of the material on which they are used. For softer wood, such as pine and deal, the angle is 25°, and the finished or sharpening angle 35°.

Commence by holding the chisel by the handle in the right hand, pressing the cutting-edge on the stone with the left, and holding the tool in the position marked A (fig. 1), the grindstone moving in the direction of the arrow. Gradually raise the tool to the position B as the ground surface assumes the proper angle. The operation is complete when this reaches the cutting-edge. It must now be completed by sharpening on the oil-stone.

During the process of grinding the stone must be wetted, the water serving the purpose of keeping the tool cool by counteracting the heat produced by friction, and also of removing particles of stone and steel, which would otherwise fill up the pores of the stone and render it useless. When not in use the stone should not be kept in water, or the part so immersed will become soft, and will consequently wear away quicker than the other parts.

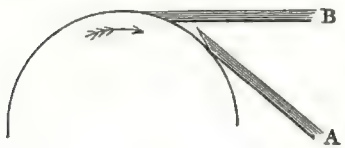


Fig. 1.

The angle at which the tool is applied to the oil-stone is somewhat different from that used with the grindstone. The tool should be held in the right hand, the necessary pressure being applied by the left hand, and in this way drawn backward and forward on the stone until the proper cutting-edge is obtained. It will require some practice to keep the tool at the same angle while doing this, and so prevent the edge becoming rounded and its keenness impaired. In the process of sharpening a slight scarf will be produced on the cutting-edge, which can be removed by rubbing the flat side of the iron on the stone, as indicated in fig. 2, B. In doing this, however, great care must be taken not to produce a bevel on that side.

Oil-stones are distinguished by the character of their grain. Those of very fine grain are slow in their action, but produce a very keen edge. The coarser-grained stones cut more rapidly, and produce the best edge for carpenters' tools. The stones are kept in a wood case, and well oiled with salad-oil, which must not, however, be allowed to thicken on the stone. Constant use causes the oil-stone to become worn and hollow in the middle, and it will be necessary to "*true*" the surface. This is done by sprinkling wet sand on a flat and level surface and rubbing the stone over it, the direction of the stone being constantly changed to correct any unevenness that may occur.

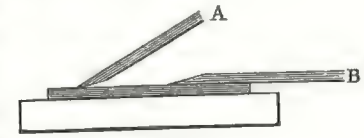


Fig. 2.

B

CHAPTER II.

SAWS.

SAWS are subject to two forces, the thrust forward and the pull backwards. The former is preferable, as giving greater efficiency; and to meet this, and prevent the blade bending under the thrust, it is made to taper towards the point, the wide part towards the handle being also made thicker than at the point.

To give the saw clearance and prevent it bending in the cut, the blade is made thicker at the teeth than at the back. As this is not found to be sufficient, the teeth are slightly bent alternately to the sides. This is called "set." For hard woods very little set is required; but when soft woods are used, the fibres not being cleanly cut by the teeth, the set has to be increased or the saw bends.

The saws in general use are known by the names rip, cross-cut or hand, panel, tenon, and dovetail. The size of the teeth is expressed by stating the number per inch.

Rip-saws (fig. 3) are used for cutting with the

grain, and are about 24″ or 26″ long in the blade, with four or six teeth to the inch. These saws remove a larger amount of the material than other saws, and it is consequently advisable when coming to a large knot to use a hand-saw till the knot is passed, or it will probably be knocked out by the force of the thrust. It will be noticed that the advancing face of each tooth is at right angles to the edge. The keenness of the saw might be increased by making this angle larger, and consequently making each tooth sharper; in fact, more resembling the cutting-edge of a chisel. But this could only be done by weakening the tooth, a thing not desirable when it is remembered that the tooth must be made of softer material than that of a chisel, in order to admit of being filed and bent for "set," and that it belongs to a tool subject to much rougher use than a chisel is.

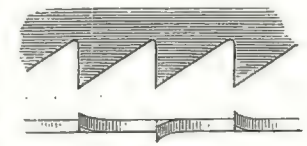


Fig. 3.

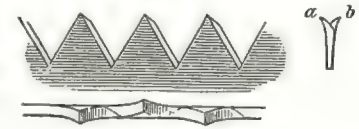


Fig. 4.

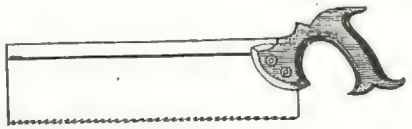
Cross-cut saws (fig. 4) are used for cutting across the grain, and are necessary because the large teeth of rip-saws would only tear instead of cut the fibres of the timber. The teeth are smaller, running to about 10 to the

inch, and form an equilateral triangle. The teeth, too, are filed so that the point of each is on the opposite side to that of the next tooth, as shown in end view. On holding the saw to the light and running the eye along the teeth, every alternate tooth has its point in a line with *b*, and the others with *a*.

The *panel-saw* is similar to the above, but has a larger number of teeth.

The *tenon-saw* has teeth similar to those of the cross-cut saw, except that the advancing face is brought forward, so that it more nearly approaches the shape of teeth of the rip-saw. This is done to increase the efficiency of the saw when used with the grain. It generally has twelve or fourteen teeth to the inch, it cuts cleaner than a panel-saw, and consequently it is used for smaller and more exact work. The blade is of uniform thickness, and is strengthened by having a brass or iron rim to back. This, however, limits its action to the depth of the blade.

The *dovetail-saw* is similar to the tenon, but is smaller, and has a larger number of teeth.



CHAPTER III.

PLANES.

THE planes in common use are, the jack-plane, the trying-plane, and the smoothing-plane. The bottom of the plane is called the face, the opening the throat, and the opening at bottom the mouth. The iron is usually fixed at an angle of 45°, but for hard woods this is increased to 60°. The smoothing-plane is about 8″ long, jack 14″, and trying-plane, 22″ to 26″. The straightness of the surface planed depends on the length of the plane. The jack-plane is used for planing down rough and uneven surfaces, which may then be smoothed with the smoothing-plane. It will easily be seen that the shortness of this plane makes it follow the hollows and ridges in the material.

Two irons are used, a cutting-iron, and a cup or "back" iron (fig. 5), which is set a little back from the cutting-edge. The distance varies, and may be as small as $\frac{1}{32}$″ in smoothing and trying planes, to $\frac{1}{8}$″ in jack-planes. The action of this iron is to break the shaving as soon as it is cut.

The jack-plane being used to cut off thick shavings, it follows that, if the iron is ground square, the plank will show rectangular grooves along its surface. To avoid this, the iron is slightly rounded in grinding. This is not the case with smoothing and trying planes, the shavings from which are very thin. Their irons, therefore, may be ground nearly square, the corners only being slightly rounded.

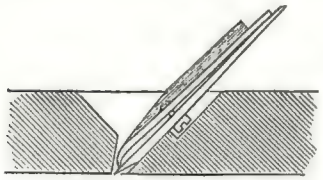


Fig. 5.

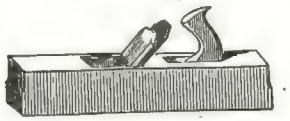
The efficiency of the plane in producing a smooth surface depends largely on the mouth. A wide mouth prevents the shaving being broken by the back iron, and produces rough work.

To set the plane in working order, after adjusting the back iron to the proper depth, insert the double iron in plane, holding the same in position with the thumb. By sighting along the face of the plane, it will be seen when the cutting-iron projects to the proper distance. Now push in the wedge: a slight tap will be sufficient to make it hold with proper firmness. If too much iron is found to project, a slight blow on the front end of the plane will rectify it; if not enough, a similar tap on the iron will bring it out to the required depth. To remove the iron, turn the plane with its face upward, hold the iron

with the left hand, and, with the right hand holding the end of the plane, knock it smartly on the bench. This is sometimes done by striking the end of the plane with a hammer, but as this disfigures the plane it should be avoided. Great care is necessary in handling planes, and for this reason the wedge should not be knocked in too hard. Indiscriminate knocking and hard usage tend to render the plane untrue, and consequently unfit for working.

All planes, especially new ones, have a tendency to warp, and as a very slight warp prevents them working, when this takes place the face must be trued up. This is done by fixing the plane in the vice, with face upward, and putting the winding-strips on. It can then easily be seen where the fault is. The face must then be shot until the winding-strips show that it is perfectly true.

New planes should have a good oiling with linseed-oil before they are used.



CHAPTER IV.

TIMBER.

If the trunk of a tree is cut through, each section will show a number of consecutive rings, with lines radiating from the centre. The former vary in thickness and colour, and denote the growth of each season, one ring being formed each year. The latter are called the medullary rays, and they bind together the rings marking the growth of the tree. The centre of the tree is dense and hard, and is called the heart-wood; the outside is the sapwood, and through this the circulation of the sap takes place.

The proper time for felling trees is when they have reached maturity, the age differing with different trees. Oak reaches maturity at about a hundred years, pine from seventy to a hundred, ash and elm from fifty to a hundred. If felled before maturity is reached the tree will not have reached its full strength and density, while after that age the tree begins to decay.

Timber is subject to shrinking and swelling. The former occurs as the timber dries and loses moisture,

and the latter as it absorbs moisture. The softer the wood the greater the amount of swelling and shrinking, according to the variations of atmospheric influence.

Timber is also liable to warp—that is, it changes its shape, or twists. This is due to unequal shrinking and swelling. If planks are cut out of a tree, they have a tendency to warp as shown in fig. 6, and if square rafters are cut they will warp according to the position of the tree from which they are cut. It is therefore necessary in planing up planks that winding-strips should be used to ascertain where the plank twists, so that it may be planed out of warp or "winding." When the timber is planed up it has a fresh tendency to warp, owing to the opening of the pores with the plane; and if it is left to itself with the flat surface exposed, it tends to become concave, by reason of one surface being more exposed than the other. It should be stood either on one edge or one end.

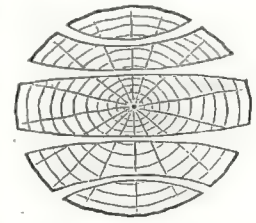


Fig. 6.

By seasoning timber we mean driving out the sap. This may be done either by natural or artificial means. In natural seasoning, which is the better method, the timber should be thoroughly exposed to the air, but protected from the sun and rain. From two to four years is required to season timber by

this method. It is seasoned artificially by subjecting it to a high temperature. This operation may be performed in a few days.

Mahogany

is a hard close-grained wood that shrinks very little, and warps less than any other timber. It takes a very fine polish, which makes it valuable for cabinet-work. It is durable when kept dry, but does not last long when exposed to the effects of weather. It is not attacked by worms. It is imported into this country chiefly from Honduras, Cuba, Jamaica, Spain, and South America. The timber is best when grown on a hard, dry, and rocky soil. That from Honduras is grown mostly on moist land, and is generally of inferior quality, being soft, coarse, and spongy. Mahogany from Cuba is of a superior kind, and is darker in colour, and sometimes beautifully figured.

Oak

is characterised by its hardness, density, and durability, and by its power to withstand the effects of exposure to the weather. It is often used underground, or even under water, and is largely used in the construction of ships.

Ash

is one of the most useful of our British trees. It grows very rapidly, but exhausts the soil very much.

The timber it yields is hard, close-grained, and tough, and is used for handles of axes and spades, spokes of wheels, &c.

Birch.

The European birch is not much valued for its timber. Hoops, bowls, spoons, &c., are made of it, as well as other articles in which lightness without much durability is required.

Of the American birches the paper or canoe birch is the most valuable. Its wood is often used in cabinetmaking, but it soon decays if subjected to alternate dampness and dryness. The bark is the most durable, and will often be found quite sound when the interior has rotted away. It is used for making canoes, thatching log-houses, &c. The American black birch yields a very valuable wood, being hard and close-grained.

Beech

is extensively used in boat-building, for work under water, carving, and for other purposes where strength and durability are required.

Teak

is a native of India, Burmah, and Ceylon. It grows to an immense size, and is remarkable for the size of its leaves, which are from 12″ to 24″ long and from 8″ to 16″ broad. It is very valuable in ship-

building, and is called the oak of the East. The wood is light, straight-grained, and easily worked, yet strong and durable. It is soon seasoned, and, from containing a resinous oil, is found to resist the action of water, as well as of insects of all kinds.

Fir.

Species of this tree form four very natural tribes, of which the following may be taken as representatives: silver fir, Norway spruce, larch, and cedar of Lebanon, and the quality of timber derived from these trees varies very much. That from the first is of little value, being neither sound nor durable, and it is only used in the manufacture of laths and other coarse indoor work. Its bark, however, is valuable for tanning, and when mixed with oak is better than oak-bark alone. The Norway spruce fir is a native of the mountainous part of north Europe. It yields a wood of a white colour, with a fine even grain, and is very durable. It is known in the market as white or Christiania deal. A species of this tree, known as the *Abies Douglasii*, or Douglas fir, is found in the immense forests of North America, and attains a height of from 100′ to 180′, with a diameter of from 2′ to 10′. It yields a wood heavy, firm, of deep colour, with very few knots, and very little tendency to warp. The larch is a native of middle Europe, Russia, and Siberia, and has been extensively introduced and cultivated upon the barren and exposed districts of England and Scotland.

The cedar of Lebanon, although not attaining a very great height, has huge outspreading branches, each of which is almost a tree in itself. The wood is very close-grained, and takes an excellent polish. It is very durable, and so resinous that laths of it are used for candles. A similar tree, known as the sacred Indian fir, and which is found in Nepaul and Thibet, also yields a very durable wood. Pieces have been discovered which have formed parts of a bridge and been under water for four hundred years.

Elm.

The elm, on account of the ease with which it may be cultivated, is perhaps the most common tree of Europe. The timber, however, is very apt to shrink and warp, and is liable to the attacks of insects, which prove very destructive to it. A great recommendation of this tree is its endurance of a smoky atmosphere, and its power to thrive near a large city. The fine elms of some of the London squares and parks are a testimony to this fact. The wood, which loses a great deal in seasoning, is of a brownish colour, hard, fine-grained, and withstands the action of water. On this account it is used in the making of pumps, water-pipes, the keels of ships, &c.

Pine.

There are many varieties of this tree, nearly all yielding timber valuable for manufacturing purposes. The Scotch pine furnishes what is known among carpenters as red deal. The yellow pine, a wood of similar texture though differing in colour, is a common inhabitant of America. Both these woods are highly prized; they are easily worked, very durable, light, and clean. Pitch-pine, also a native of America, is a close-grained, hard, and durable wood. It is largely used in shipbuilding and cabinetmaking.

CHAPTER V.

CARPENTER'S BENCH.

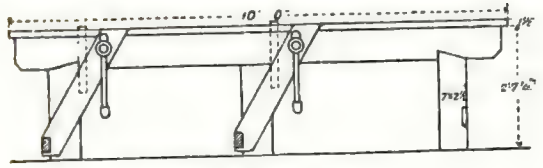


Fig. 7.

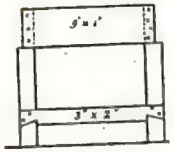


Fig. 8.

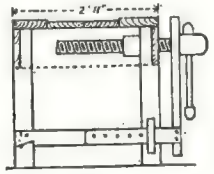


Fig. 9.

A BENCH (fig. 7) 10′ long and 2′ 11″ wide will provide sufficient accommodation for four boys.

Directions.—Prepare six legs, 7″ × 2½″ × 2′ 7½″, and frame together as shown in fig. 8, the top rail being 9″ × 1″ and the bottom 3″ × 2″. Allow for the face-board on each side to be bevelled into the leg. This will bring the front flush and give greater rigidity to

the bench. The top should be screwed on, and may consist of four boards $9'' \times 1''$, or the two outside boards may be $9'' \times 1\frac{1}{2}''$.

For the vice (fig. 9) a piece of red deal $7\frac{1}{2}'' \times 2''$ forms a very good jaw, and should be provided at bottom with fillet to work in box fastened to leg. A wooden screw which has been well blackleaded is best, the screw-block being screwed on to inside of face-board.

For bench-stop a piece of hard wood 2″ square may be let in through top of bench and made to work between fillets nailed on. This can be raised or lowered as required, and will save some damage to tools.

CHAPTER VI.

MODELS IN CARDBOARD.

A COURSE of lessons in making models from cardboard will be of very great service in training boys to neatness and accuracy of work, and in enabling them to form correct ideas of the views of models in different positions. It will be especially useful, too, in enabling them to grasp the idea of sections. A complete set of these models, showing sections, can be easily made, and will be found to be of the greatest assistance in teaching solid geometry to Standard VI.

A few drawings are given (figs. 10-17), showing the shape the cardboard must be cut.

Directions.—Cut the edges clear with a sharp knife, and cut half through the dotted lines, fold over into shape, and join the edges by gumming thin strips of paper over them. The models may be made to any size. A cube of 3″ or 4″ sides will be found a very convenient size.

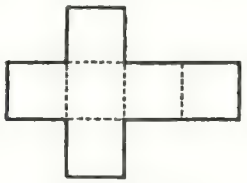


Fig. 10.

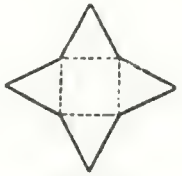


Fig. 14.

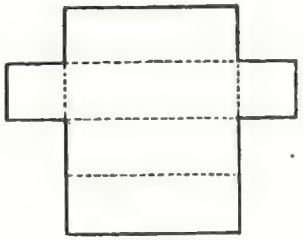


Fig. 11.

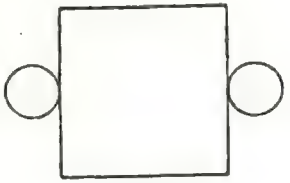


Fig. 15.

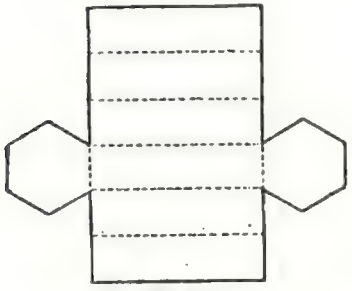


Fig. 12.

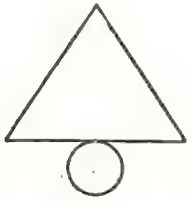


Fig. 16.

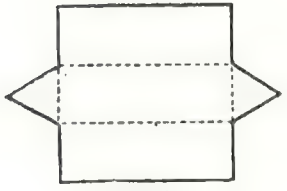


Fig. 13.

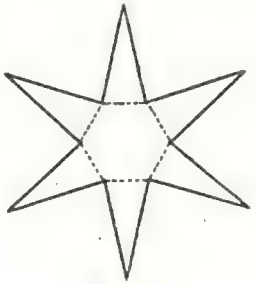


Fig. 17.

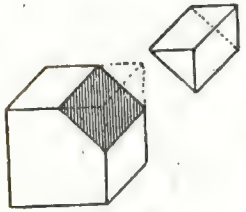


Fig. 18.

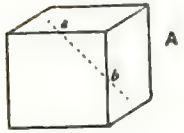


Fig. 19.

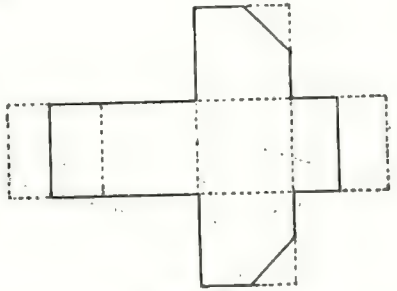


Fig. 20.

Sections.

Suppose a model is required of the cube, showing section *ab*, fig. 19.

Directions.—Cut out model in cardboard, as described, and fold together to form the cube. Now mark the section with pencil-line all round, open out again, and cut off parts on section lines. Now make up both parts of model. The section surfaces may be covered with different-coloured paper.

Sections of all the models, illustrations of which follow, may be made in the same way.

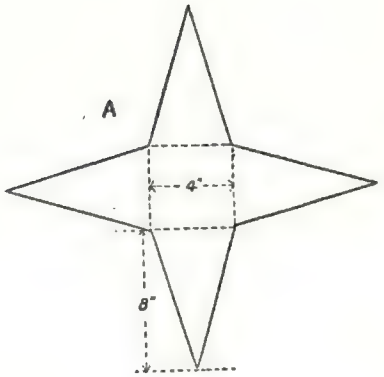


Fig. 21.

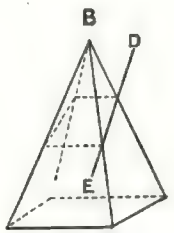


Fig. 22.

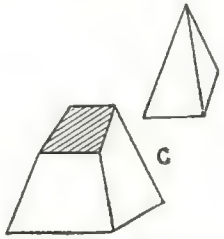


Fig. 23.

A shows the method of marking out the cardboard with the dotted lines, which are to be partially cut through with a sharp penknife. The model is then to be folded into its proper shape, and the section marked as shown in B. Next open the model and cut off the section. The two parts are then to be folded into proper shape, and the edges fastened together by gumming strips of paper over them. The plane of the section should be covered with different-coloured paper. C shows the parts complete.

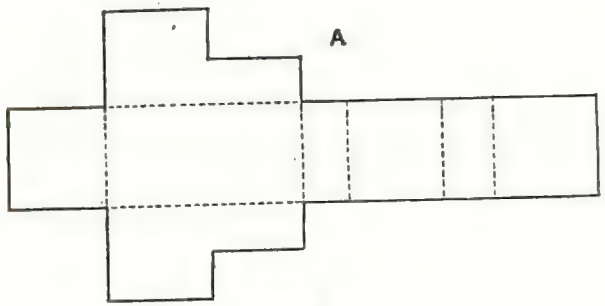


Fig. 24.

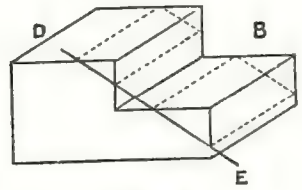


Fig. 25.

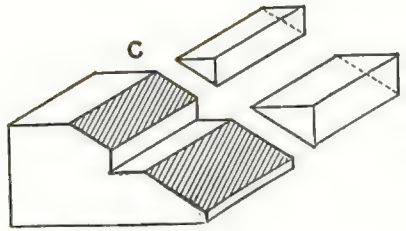


Fig. 26.

SECTIONS OF MODELS IN CARDBOARD.

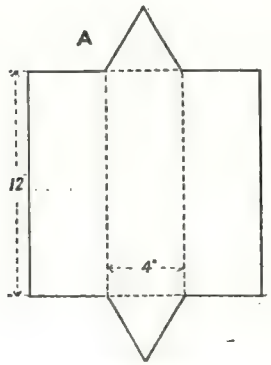


Fig 27.

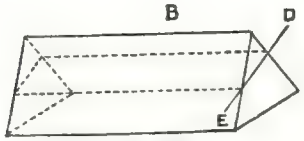


Fig. 28.

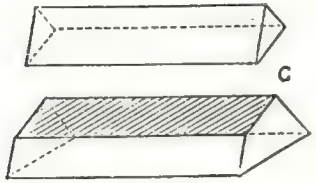


Fig. 29.

SECTIONS OF MODELS IN CARDBOARD.

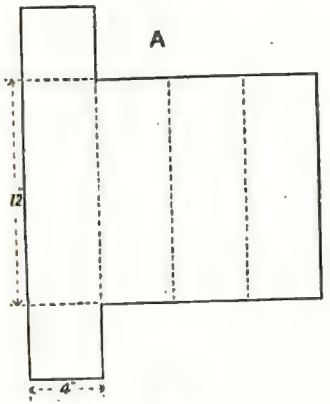


Fig. 30.

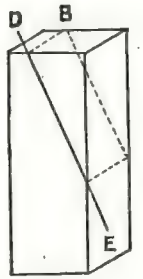


Fig. 31.

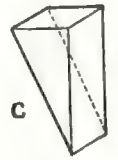


Fig. 32.

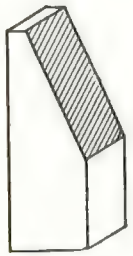


Fig. 33.

SECTIONS OF MODELS IN CARDBOARD.

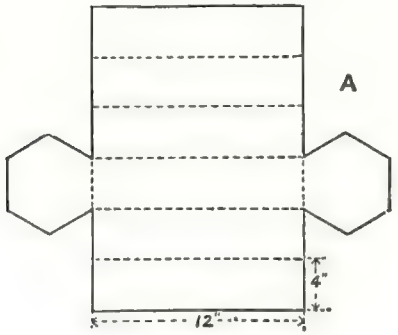


Fig. 34.

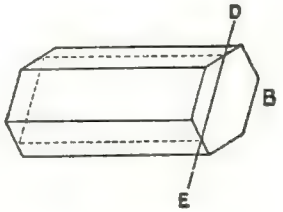


Fig. 35.

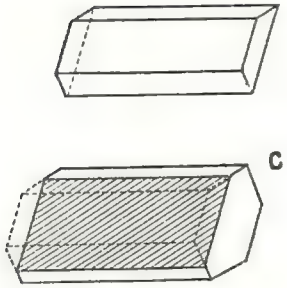


Fig. 36.

SECTIONS OF MODELS IN CARDBOARD.

CHAPTER VII.

DRAWING.

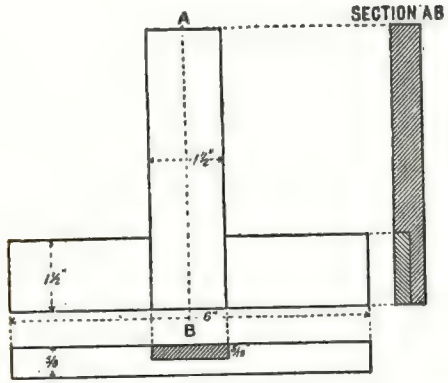


Fig. 37.

A SPECIMEN of the kind of drawing that should be practised is here given. The joint given in fig. 37 is chosen, two views and a section being given. The drawing should be made full size, and the accuracy of the work tested by fitting the different parts on the drawing.

CHAPTER VIII.

PLANING.

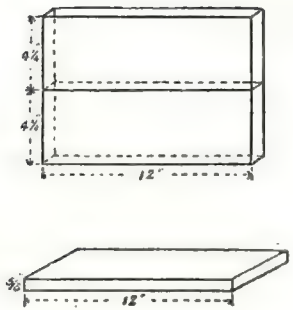


Fig. 38.

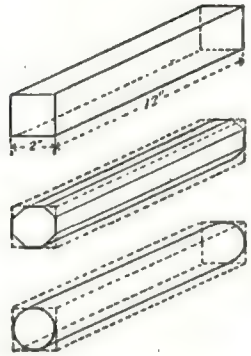


Fig. 39.

THE pupils should early be taught to cut out and plane up pieces of stuff to a given size. It is better to commence with small pieces.

Directions.—Take a $\frac{3}{4}'' \times 9''$ board. Draw lines dividing it into five strips by gauge, and cut down, cutting the strips to 13″ in length. To plane up, commence by shooting one edge square, and then plane one of the flat surfaces square with the edge

already planed. Place tried-up mark on this side, and then plane other flat surface square. A uniform thickness is obtained by gauging from planed-up side with gauge set to $\frac{5}{8}''$. Set gauge to $1\frac{1}{2}''$, run lines down both flat surfaces, and plane down to gauge-lines. Pieces will thus be prepared $13'' \times 1\frac{1}{2}'' \times \frac{5}{8}''$. These pieces will give practice in planing, and may then be put on one side to be used in future lessons on the different joints.

Next, take similar board, $9'' \times \frac{3}{4}''$, cut down middle and to a length of 12″. Plane these up true. To test the accuracy of the edges, put one on the other (fig. 38) and hold up to the light. If a good joint is made no light can be seen through.

A further practice in planing is shown in fig. 39. Prepare three pieces $12'' \times 2'' \times 2''$. On either end of one piece inscribe an octagon, and plane down to octagonal sides. Next inscribe a circle on each octagonal end, and plane down to the circle, finishing off with glass-paper to produce smooth surface (fig. 39).

The next exercise should be to plane up pieces 9″ wide. To do this accurately, winding-strips and straight-edge are necessary. To make the latter (fig. 40), prepare a piece of pine, sound, straight-grained, and free from knots, $3'\ 6'' \times 3'' \times \frac{7}{8}''$. From the centre of one edge bevel down to 2″ at each end. To prove that the edge is straight, lay it on a flat board and mark the edge on the board with pencil, now turn the strip over, not reversing the ends. By this

means any imperfections will be doubled, and these can be remedied by shooting with trying-plane.

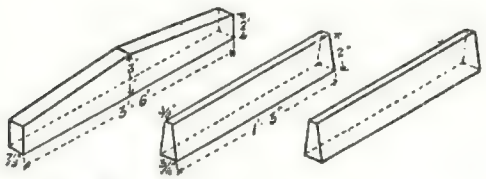


Fig. 40.

Fig. 41.

Winding-strips should be made of straight-grained hardwood, say mahogany. Prepare two such strips $15'' \times 2'' \times \frac{3}{4}''$, and bevel down one side from $\frac{3}{4}''$ to $\frac{3}{8}''$ (fig. 41). The edges should be tested as to their accuracy according to plan given in preceding paragraph.

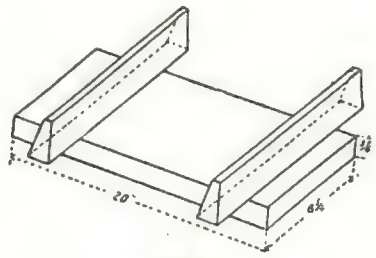


Fig. 42.

From $9'' \times \frac{3}{4}''$ board cut off pieces 20″ long and shoot one edge square. Lay pieces flat on bench, and test flatness with winding-strips, putting them as shown in fig. 42. By stooping and sighting the

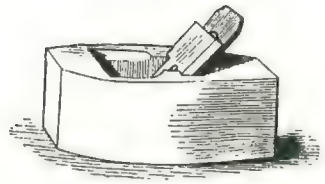
edges of winding-strips, it will be seen at once whether the board is perfectly flat, and where it wants planing. When this side is made perfectly flat and true, the tried-up mark may be placed on it, and the other side proceeded with in same way.

These pieces may then be put away for a future lesson.

The lesson on planing may be made both interesting and useful by setting the pupils to plane up and cut out pieces of stuff to the various geometrical patterns to which they are accustomed in their drawing lessons. This will provide both a useful exercise in planing and sawing, and will accustom the boys to the use of the compass, and to planing across the grain.

Use a $\frac{3}{4}''$ board 9″ wide, which should be cut down the middle. Give each boy a piece about 18″ long, and this will enable him to cut out four pieces, which, when finished, will be $4\frac{1}{4}''$ square. The two edges with the grain will already be planed square. He should then be practised in planing across the grain. To do this the piece is fixed in the screw, and the smoothing-plane, set very fine, is used. Great care must be taken that the plane is not used right across the stuff, or the end fibres of the wood will be torn out, and a piece split off. One half should first be planed, and then the piece turned round in the screw, when the other half can be planed.

When the pieces are thus prepared, a rectangle, equilateral triangle, octagon, and hexagon may be made. The exercise may be continued in a variety of ways, which will readily suggest themselves to the teacher. The edges of the figures should be smoothed off with the plane before being finished with glass-paper.



CHAPTER IX.

HALVING.

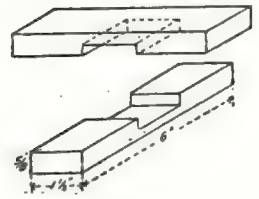


Fig. 43.

THE next lessons are on the different joints formed by halving.

Directions.—Take $\frac{3}{4}$" board and cut into five strips of equal width, and plane up to $1\frac{1}{2}" \times \frac{5}{8}"$; cut off 13" long. Each strip will be sufficient for one joint (fig. 43). Square the ends and cut into two pieces 6" long. Set gauge to $\frac{5}{16}"$, and run gauge-line down centre of each side. To halve out, mark the middle and square a line $\frac{3}{4}"$ on one side of it, then set the other piece to this line and mark the width by running line on the other edge. With tenon-saw cut down to gauge-line, taking care to cut inside of

pencil-line, so as to make a tight joint. Clear out with sharp chisel, fit together, and clean off. The joint in this and the following lessons must be made so that it fits tightly together, and holds without the help of glue.

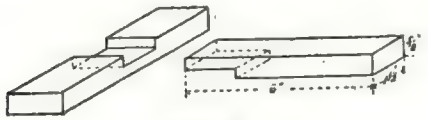


Fig. 44.

Prepare piece of same dimensions as in preceding lesson, and cut out two pieces 6″ long (fig. 44). Run gauge-line round, and cut tenon out. Now fit tenon to get width of socket, and clear out with sharp chisel. To obtain a good joint, great care is required in cutting inside of pencil-lines, so that the tenon is driven in with hammer, and a tight joint obtained.

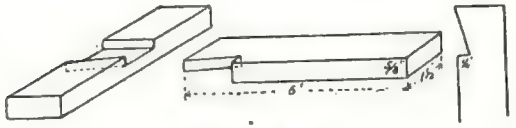


Fig. 45.

Proceed as in former lesson, and having cut the tenon, cut out the shoulder, tapering from $\frac{1}{4}$″ at root to nothing at the edge (fig. 45). Having squared

one line on the other piece, fit the tenon to this line and mark the shoulder off. Cut down with saw and clear out with chisel. Plane off, and finish with glass-paper. To preserve the sharp edges, use the glass-paper wrapped round a small block of wood.

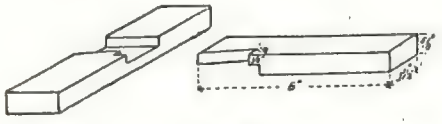


Fig. 46.

This joint is similar to the last, but has a double shoulder (fig. 46). Make each $\frac{1}{4}$″, and having made the tenon, fit it on the second piece, marking the outline carefully with pencil. Cut down with tenon-saw and clear out with chisel. Plane off, and finish with sand-paper.

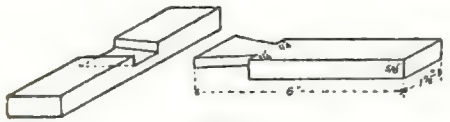


Fig. 47.

After making the last few joints no difficulty will be found with the above (fig. 47). Proceed as before, and after making the tenon, mark the shape on the other piece and cut out.

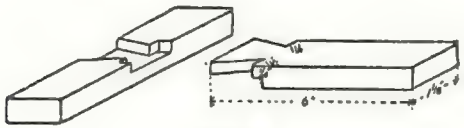
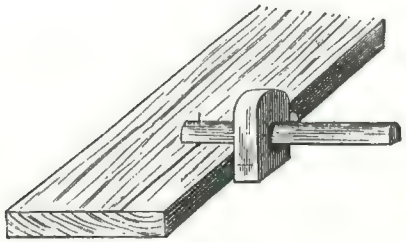


Fig. 48.

No further directions will be needed in making this joint (fig. 48).



CHAPTER X.

SQUARE JOINT.

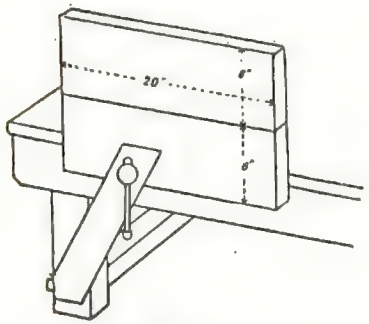


Fig. 49.

THE pieces prepared in a former lesson may now be used for the exercise on the square joint.

Directions.—Cut off strip $\frac{3}{4}$" from both pieces and plane edges perfectly square, testing by holding the edges to the light and seeing that no light passes through the joint. When this is obtained the joint is ready for gluing. Fit one piece in vice, and holding the two edges together run the glue along with a brush. The glue must be hot. Now make the joint

by putting one piece on the other, and proceed to rub out all unnecessary glue by drawing backwards and forwards. It will easily be felt when the glue is setting. If the piece cannot be left in the vice till the joint is hard, take it out by the bottom board and lean it against a strip sloping against the wall.

This may now be put on one side till the lesson on grooving and tonguing, when it may be made into a drawing-board.

CHAPTER XI.

GROOVING AND TONGUING.

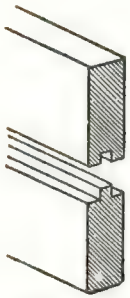


Fig. 50.

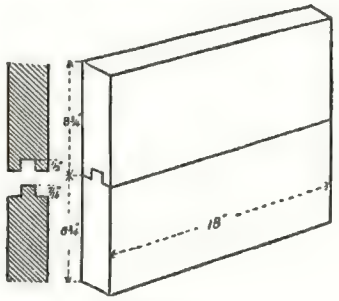


Fig. 51.

1. *With Match-Planes* (figs. 50, 51).

THESE are sold in pairs—one cuts the groove, and the other the tongue.

Directions.—Prepare two pieces of $8\frac{3}{4}'' \times 1'' \times 18''$ by shooting edges and levelling with winding-strips. On one edge prepare the tongue, and on the other the groove. The tongue is made $\frac{1}{16}$ less than the groove.

This joint may also be used for the exercise on keying.

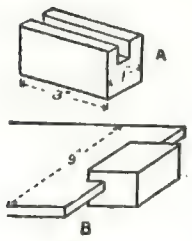


Fig. 52.

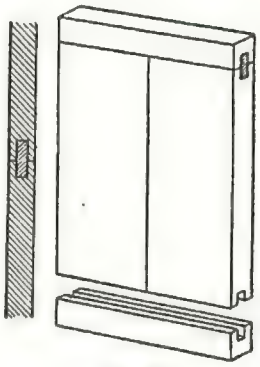


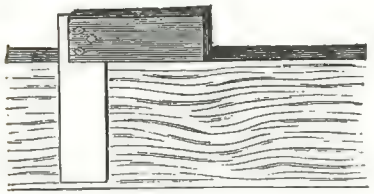
Fig. 53.

2. *With Plough and Cross-Tongue.*

First prepare the tongue. Make a template by running same groove as is used for joint, on a piece of inch stuff, as shown in fig. 52, A. Now take a 9″ thin board, and having cut one corner diagonally, try with template whether it is of right thickness, and with cutting-gauge cut off strips 1″ wide to form the tongues.

Now take the square joint of fig. 49 and shoot the ends perfectly square, plough groove along both ends, using same iron for plough as was used in making the groove in the template. Prepare two clamps from strips $16\frac{1}{2}'' \times 2'' \times \frac{7}{8}''$, having ploughed groove on one side. The tongue may now be glued into one end and the clamp glued on to tongue. When both

ends are thus done put board away till quite dry and hard, and finish off with smoothing-plane and glass-paper. The grooves should be ploughed $\frac{9}{16}$ deep, and in gluing a stop may be fixed on end to prevent the tongue shifting in the process of rubbing out the glue.



CHAPTER XII.

BENCH-HOOK OR SAWING-BLOCK (fig. 54).

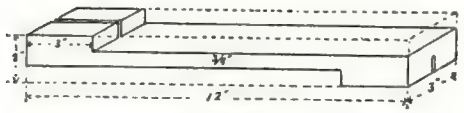


Fig. 54.

Directions.—Prepare a piece $12'' \times 3'' \times 2''$. Square line 3″ from either end on opposite surfaces. Set gauge to $\frac{5}{8}''$, and run gauge-line on both edges. Cut out as shown above, and make saw-cut on each shoulder, one of which is used as a stop against the edge of the bench, the other as a stop to the piece to be sawn.

This bench-hook will save a great deal of damage to bench.

CHAPTER XIII.

KEY-JOINT (fig. 56).

Fig. 55.

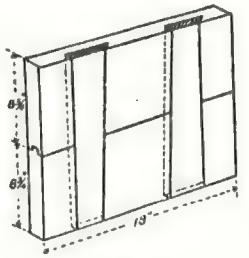


Fig. 56.

Directions.—First prepare the keys from piece $10'' \times 4\frac{1}{2}'' \times \frac{3}{4}''$, and cut down as shown in fig. 55. Two keys will thus be prepared, one side of which will be straight and the other tapering from $2\frac{1}{2}''$ to 2″. Now bevel the two edges to an angle of 60°. The board must now be prepared. Run line on edge with gauge to mark depth. Cut groove for key so that each edge shows one narrow end and one wide end of key. The splayed shoulders are cut by holding tenon-saw on bevel to an angle of

60°, and the material is cleared out with sharp chisel. If the keys fit too tightly they may be eased by taking a shaving off, but they must be fitted so as to be driven in tightly.

The keys are sometimes planed off flush with surface of board, or they may be left standing up above the surface.

CHAPTER XIV.

MORTISE AND TENON (figs. 57, 58).

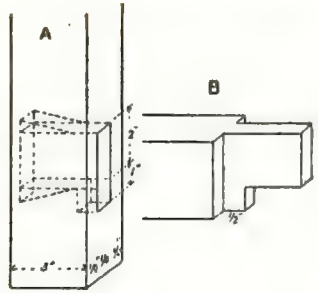


Fig. 57.

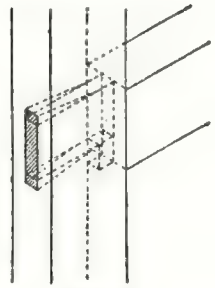


Fig. 58.

Directions.—Cut out and plane up two pieces $9'' \times 3'' \times \frac{3}{4}''$, and set out piece A for mortise and B for tenon. The thickness of the tenon is generally made $\frac{1}{3}$ of the thickness of the piece used, and the width about six or eight times the thickness. In this case the thickness of tenon is $\frac{1}{4}''$. Set mortise-gauge to that thickness and mark off on B. Cut down to shoulder with hand-saw, and cut off clean with tenon-saw, taking care to cut perfectly square. When a sharp clear edge is required, it is better to

square with a line made by bench-knife or sharp penknife, as the saw cuts cleaner when this is done than it does to a pencil-mark. A piece is cut out of the tenon to form the haunchion, and this piece is generally used for the wedges. Having set out width of tenon on mortise piece, run gauge on both sides and square all round the piece. On one side groove out to $\frac{1}{2}''$ depth to receive haunchion, and on the other side cut mortise $\frac{1}{4}''$ wider on each side, as shown by dotted lines, to receive wedges. Glue up, driving in wedges, and plane off clean.

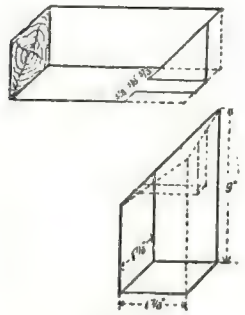


Fig. 59.

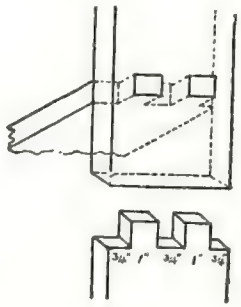


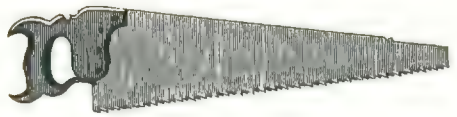
Fig. 60.

Fig. 59 shows a mitre tenon.

Directions.—Prepare two pieces $9'' \times 1\frac{7}{8}'' \times 1\frac{7}{8}''$, and cut one end to mitre. Set gauge to $\frac{5}{8}''$, and mark on two sides. Mark pencil-line for mitre, cut down with tenon-saw to form shoulder, and then cut out tenon. Mark mortise out with gauge on mitre end

of the other piece and mortise out. Keep to outside of line in cutting out tenon, so that the joint may be tight.

For fig. 60 prepare two pieces $9'' \times 4\frac{1}{4}'' \times \frac{7}{8}''$. Cut out tenons as shown, making them a little longer than the thickness of the stuff to allow for cleaning off. In cutting the mortises allow for wedges.



CHAPTER XV.

DOUBLE TENON.

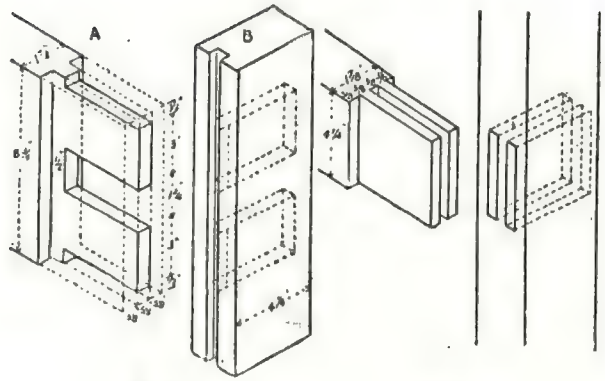


Fig. 61.

Fig. 62.

Two cases of double tenon are here shown.

Directions.—For fig. 61 prepare two pieces, one $12'' \times 8\frac{3}{4}'' \times 1\frac{7}{8}''$, and the other $15'' \times 4\frac{1}{4}'' \times 1\frac{7}{8}''$. Set out B for mortise and A for tenon, according to dimensions given. B has a groove $\frac{5}{8}''$ wide and $\frac{1}{2}''$ deep ploughed down one edge. Cut tenons down with hand-saw, and having cut out haunchions on

outside of both tenons, cut out centre with chisel. Now mortise B, cutting mortise on outside to allow for wedges. The grooving is best done after the mortise is cut. In mortising, great care must be taken to keep the chisel from twisting. There is a tendency for it to do this, with the result that the work will not be square when finished.

In fig. 62 the pieces should be $9'' \times 4\frac{1}{4}'' \times 1\frac{7}{8}''$. Set out according to dimensions given, and cut out as before directed, cutting out material between the double tenon with $\frac{3}{8}''$ chisel.

CHAPTER XVI.

SQUARE AND MITRE-SQUARE.

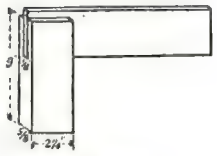


Fig. 63.

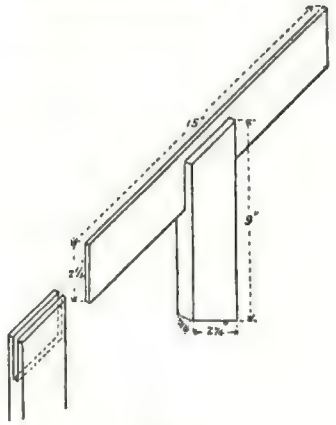


Fig. 64.

Directions.—For fig. 63 prepare piece $9'' \times 2\frac{1}{4}'' \times \frac{5}{8}''$, and another $12'' \times 2\frac{1}{4}'' \times \frac{1}{8}''$. The thin blade is prepared by planing a piece of $\frac{1}{4}''$ board down to $\frac{1}{8}''$. Mortise carefully, and glue the blade in.

For fig. 64 prepare one piece $9'' \times 2\frac{1}{4}'' \times \frac{5}{8}''$, and the other $15'' \times 2\frac{1}{4}'' \times \frac{1}{8}''$. Great care will be required in cutting the mortise so that the mitre shall be true.

The above form two very good and useful exercises for boys.

CHAPTER XVII.

DOVETAILING.

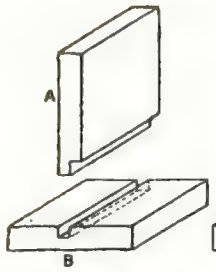


Fig. 65.

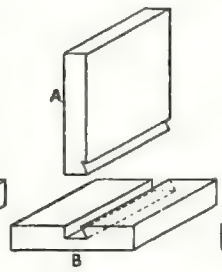


Fig. 66.

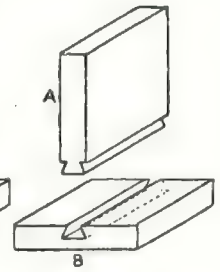


Fig. 67.

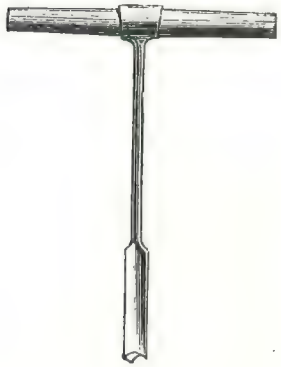
Directions.—Prepare six pieces $9'' \times 4\frac{1}{2}'' \times \frac{7}{8}''$.

In fig. 65 the groove and tongue are square. In piece A, prepare the tongue by marking out with gauge, and cutting down with tenon-saw, and clearing out with chisel.

In fig. 66 the tongue is bevelled on one side. This is done by cutting down with tenon-saw and cutting out with sharp chisel. In making groove, one side

is cut down square with tenon-saw, and the other cut with saw on the bevel.

In fig. 67 both sides of tongue and groove are bevelled. This joint is also made with the tongue tapering, and an excellent joint is made when the tongue is driven home tight in the groove.



CHAPTER XVIII.

COMMON DOVETAIL (fig. 68).

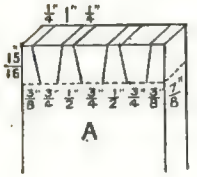


Fig. 68

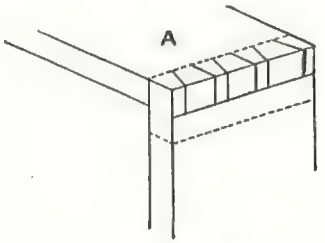


Fig. 69.

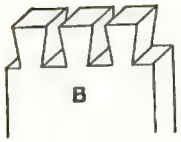


Fig. 70.

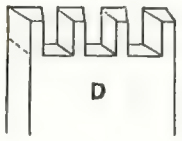


Fig. 71.

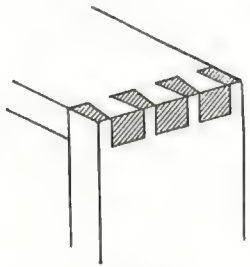


Fig. 72.

Directions.—Prepare two pieces of inch stuff, and plane up to $9'' \times 4'' \times \frac{7}{8}''$ with square ends. Set gauge $\frac{1}{16}$ more than the thickness of timber, and run gauge-lines round, as shown by dotted lines.

Take one piece, A, and mark lines as shown, then cut down to gauge-line with dovetail-saw. Now fix the other piece in the vice, and holding A firmly on the end as shown above, mark through the previous saw-cuts with saw. Now clear out the sockets of A as shown at B with sharp chisel. Cut down the marks made in end of second piece to gauge-line, and clear out sockets with sharp chisel. Try the joint thus made and then glue up. The gauge-line on A being set $\frac{1}{16}$ more than thickness of stuff, will allow for planing off when the joint is dry.

CHAPTER XIX.

LAP DOVETAIL (fig. 73).

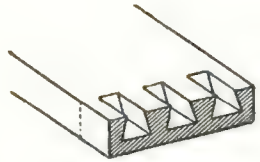


Fig. 73.

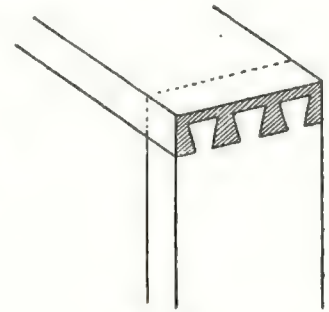


Fig. 74.

Directions.—Proceed as in previous lesson, cutting out one piece as A, except that the gauge must now be set to $\frac{5}{8}$". Run gauge along the edge of other piece, and mark the saw-cuts as previously described. Clear out the piece B, as shown in fig. above, and glue up. The gauge-line on B being set $\frac{1}{16}$ more than thickness of stuff, allows for planing off when the joint is dry.

CHAPTER XX.

MITRE DOVETAIL.

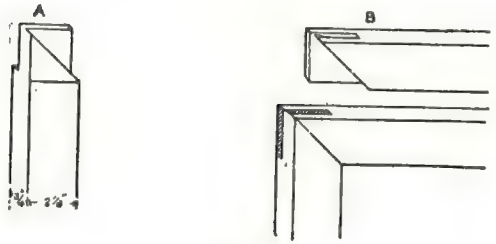


Fig. 75.

THE above is a very good joint for picture-frames.

Directions.—Prepare two pieces $9'' \times 2\frac{1}{8}'' \times \frac{3}{4}''$, and set out as for ordinary mortise and tenon, gauge being set $\frac{1}{4}''$. A rebate will be formed on one side of pieces; set mitre on the other side and cut down the tenon with hand-saw—on one side to the square shoulder and on the other to the mitre joint. The piece B will have to be cut down to the square shoulder and mortise cut out with chisel. When well done this forms an excellent joint.

CHAPTER XXI.

NOTCHING.

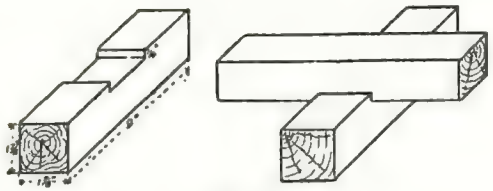


Fig. 76.

Directions.—Take piece of stuff $18'' \times 2'' \times 2''$ and plane up to $1\frac{7}{8}''$ square. Cut into two pieces 9″ long. Cut the notch $\frac{1}{4}''$ deep, obtaining the exact width by fixing the other piece to squared line and running pencil-mark along the edge (fig. 76).

Prepare two pieces of same dimensions as in preceding lesson. Each notch should be $\frac{5}{8}''$ wide and

and $\frac{1}{4}$" deep. Cut out with tenon-saw and chisel (fig 77).

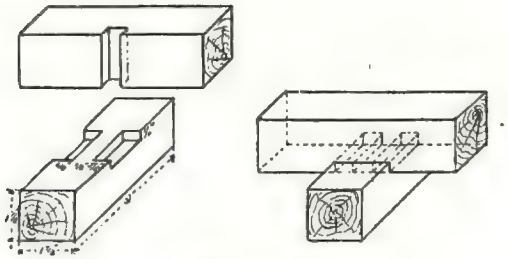


Fig. 77.

After the preceding lessons have been worked no difficulty will be felt in working this lesson (fig.

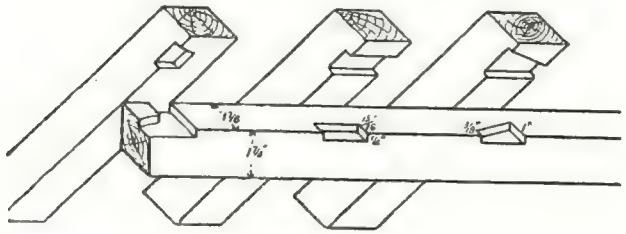


Fig. 78.

78). The timber should be of same dimensions as before.

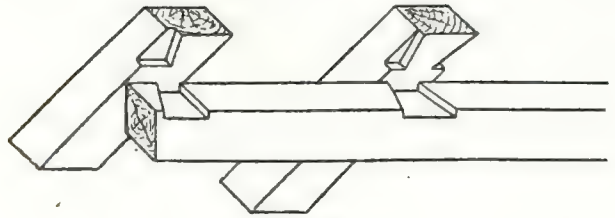


Fig. 79.

In this and the preceding lesson the joints may be made separate or combined, as shown (fig. 79).

CHAPTER XXII.

DOWELLING.

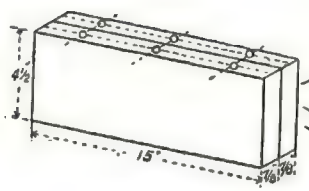


Fig. 80.

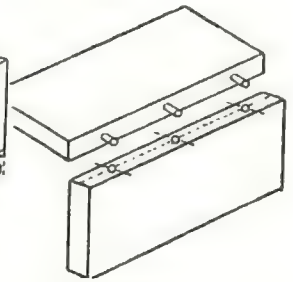
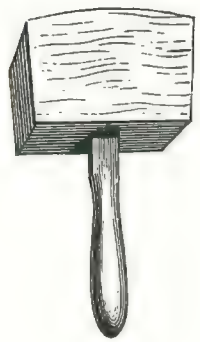


Fig. 81.

Directions. — Prepare two pieces 15" × 4½" × ⅞". Put them together as shown (figs. 80, 81), and square lines across edges to mark places for dowel-holes. Run gauge-line down centre of each edge, and the exact places for the holes will then be found. This must be done accurately, or the edges and ends will not coincide when the dowelling is done. Bore holes with ⅜" bit 1½" deep, keeping the bit perfectly upright while doing so. To make the dowels, prepare a template of hardwood and bore

two holes with same bit in it. Now take a piece of ⅜" straight-grained wood, and with chisel split off pieces about ½" thick, and pare down to fit holes in template. They must be cut so as to require driving into the holes. Now glue them into one piece and cut off projecting end to required length, and fit other piece on.



CHAPTER XXIII.

MITRING.

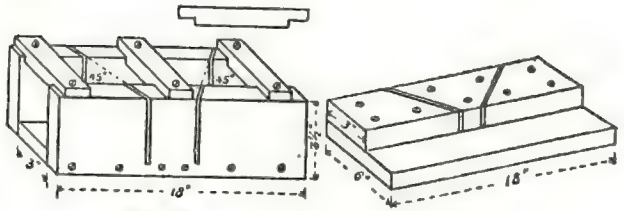


Fig. 82.

Fig. 83.

Directions.—Prepare two pieces $18'' \times 3\frac{1}{2}'' \times \frac{7}{8}''$, and one piece $18'' \times 3'' \times \frac{7}{8}''$; also three strips $4\frac{3}{4}'' \times 1\frac{1}{2}'' \times \frac{7}{8}''$, cut as shown in fig. 82. Screw together to form box, using strips for the top as shown. Set bevel to 45°, and mark the two lines for saw-cut, squaring down on either side. Make saw-cut with tenon or panel saw. The lines may be marked by forming square on the top and marking diagonal. For the mitres for small mouldings, &c., a block similar to fig. 83 is sometimes used.

Prepare two pieces, one $18'' \times 6'' \times \frac{7}{8}''$ and the other $18'' \times 3'' \times \frac{7}{8}''$, perfectly true and square. Screw firmly

together. Mark the mitre-cut, and cut down as shown (fig. 83).

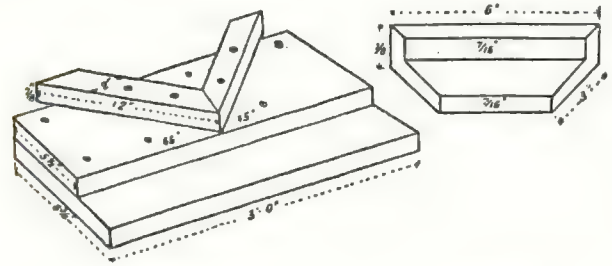


Fig. 84.

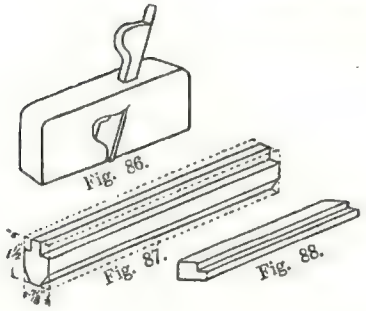
Fig. 85.

Fig. 84 represents the mitre-shoot. Prepare one piece $36'' \times 8\frac{3}{4}'' \times \frac{7}{8}''$, and another $36'' \times 5\frac{1}{2}'' \times \frac{7}{8}''$. They must be planed up perfectly true and then screwed together. Now prepare two strips $12'' \times 2'' \times \frac{7}{8}''$ and mitre together. Screw on to board at angles of 45°. The shoot is used for planing up the mitres after they have been cut in the mitre-box.

The mitre template shown in fig. 85 is used for cutting mitres of beads and moulding in framing. Prepare a piece of oak, birch, or mahogany $6'' \times 3'' \times \frac{7}{8}''$. Rebate out to depth of $\frac{7}{16}''$. Cut ends in mitre-box, and plane in mitre-shoot.

CHAPTER XXIV.

REBATING.



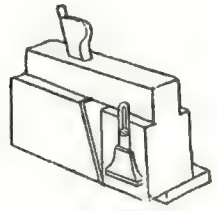


Fig. 89.

Fig. 90.

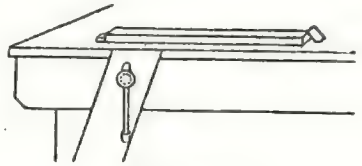


Fig. 91.

REBATING may be done either with the rebate-plane or with the side-fillister. By the first method, after the piece has been prepared a plough-groove is run down the bar and the material planed out with the rebate-plane.

Directions.—The plough-groove is not necessary when the side-fillister is used. The bar at the bottom of the tool is adjustable by two screws, and the width of the rebate is regulated in that way. The brass slide on the side of the plane will give the depth of the rebate, and may be set to any depth by means of a screw. Suppose a sash-bar has to be made. Plane the bar up to a thickness of $\frac{7}{8}''$ and width $1\frac{1}{2}''$. Set fillister to a depth of $\frac{1}{4}''$ by means of brass slide, and width of $\frac{1}{2}''$ by bar at bottom. Fix the bar on the bench by means of bench-knife, driving it into the bar and the bench, and cut out material by means of plane. Reverse the bar and cut out rebate on the other side.

CHAPTER XXV.

CHAMFERING.

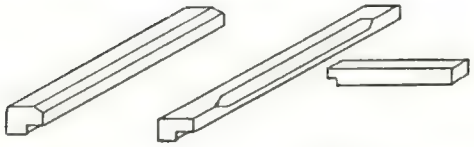
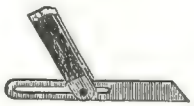


Fig. 92. Fig. 93.

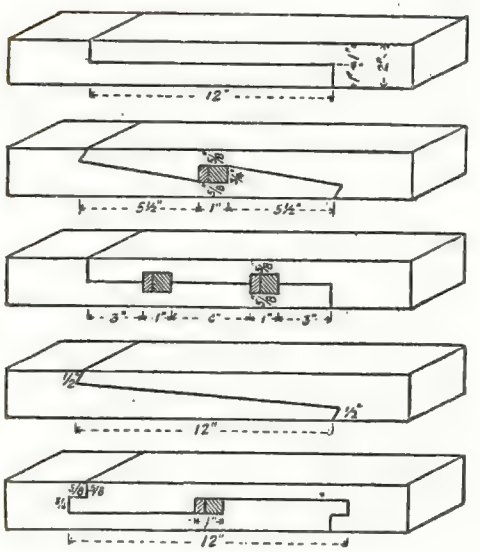
Directions.—Prepare a small wood gauge set to $\frac{1}{4}''$ or $\frac{3}{8}''$, and mark with pencil-lines to form the chamfer. In the case of fig. 92 the chamfer is made by planing down to the gauge-lines.

Fig. 93 shows case of stop-chamfer. The stop is formed by marking line with mitre template, the material being cut out with sharp chisel.



CHAPTER XXVI.

SCARFING.



JOINTS used to lengthen timbers without increasing their bulk at the joints are called scarfed joints. Such joints are usually subject to the strains of (1) compression tending to reduce their length, (2)

tension tending to increase their length, (3) cross or bending strain. Under this latter strain the fibres of the upper half will be subject to a compressive strain, those of the lower half will be subject to a tensional strain, while the middle line will form a neutral axis.

The rules to be observed in making scarfed joints are—to cut the timbers so as to weaken them as little as possible, to place each abutting surface as nearly as possible perpendicular to the pressure it has to transmit, to proportion the area of each surface to the pressure it has to bear, and to fit the surfaces as accurately as possible so that the stress is uniformly distributed.

The joints are sometimes strengthened by means of bolts and iron fish-plates.

Figs. 94 and 95 show two joints used to resist the force of compression, and fig. 96 to resist tension. A scarfed joint for resisting the cross or bending strain is shown by fig. 97, and fig. 98 shows a joint for resisting the combined forces of compression and tension.

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